From Science to Policy:
The Science-Related Politics of Climate Change Policy in the United States

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Abstract

Global climate change is on the political agenda primarily as a result of science and the warnings of the scientific community, and is commonly seen as a quintessentially scientific matter. However, the development of policy on this issue in the U.S. today does not turn on the scientific evidence. Rather, policy is determined by the political and economic forces involved, with reference to the science only to support positions reached on other grounds. The reasons relate primarily to the uncertainty in the evidence, the structure and politics of the government, the economic costs and impact of change and of policies to reduce greenhouse gases, the international structure in which the issue is being confronted, the role of the media, and the effects of partisan politics. In this situation, the scientific and engineering communities (including social scientists and especially economists) have a major responsibility to maintain their professional values and objectivity so dominated at the moment by other pressures. Only that way can they retain the public trust that will be necessary if and when costly policy measures must be undertaken.

Contents

Global climate change is on the political agenda primarily as a result of science and the warnings of the scientific community. The forecasts of dangerous warming of the atmosphere in the near future, fortuitously assisted by weather events that appeared to justify the forecasts, aroused governments and publics to enter into perhaps the most complicated, and significant, international negotiations ever attempted. Essential questions of the rapidity of climate change, its effects, and the options for response have energized the scientific and allied communities in analyses that are deeply dependent on scientific evidence and analysis.

The resulting national and international policy debate is unfolding rapidly. But, it is also becoming increasingly mired in controversy, nowhere more so than in the United States. How is it that the U. S., the undisputed leader in science and technology, is finding it so difficult to

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converge on agreed policies for an ecological threat that, if it materialized, could have catastrophic consequences for the nation and the world?

Perhaps the most striking observation is that this policy issue, clearly on the agenda as a result of science and permeated with scientifically-based questions, is *not* now a scientific issue.[1] That is, much of the controversy appears to revolve around science, but in fact the policy conclusions drawn from today's debate are determined primarily by the political and economic forces involved. How could that be so for an issue generally seen as quintessentially a scientific matter, and a paradigm of the kinds of scientific and technological issues nations will have to face in the future?

The explanation lies in the many factors at work as the policy process is forced to encounter, assimilate, contest, modify, ignore, and otherwise respond to the presentation of scientific evidence and analysis on an issue that raises questions as varied and politically or economically sensitive as (among others) contesting interests, environmental dangers, differing national policy processes, distribution between haves and have-nots, intergenerational equity, national sovereignty, and the function and competence of international institutions,[2] What are the primary factors that determine policy outcomes on this complex subject? Detailing them can demonstrate in a vivid way on a particularly significant issue how knowledge interacts with the formulation and development of policy in the U.S.

Background

In December of 1997 a Protocol to the Framework Convention for Climate Change (FCCC) was negotiated in Kyoto, Japan, aiming for the first time to set mandatory limits on greenhouse gas emissions of industrial nations. Under the Kyoto Protocol, the U.S. would be committed to a reduction of emissions to 7% below the levels of 1990 by the years 2008–2012. Only Annex I countries—the industrialized countries of the OECD and of the former Soviet Union and Eastern Europe—are assigned commitments under the Protocol. Non-Annex I countries have assumed no formal obligations to regulate emissions. The FCCC, which included no mandatory target reductions, was agreed to in Rio de Janeiro in 1992 and has been signed and ratified by 175 countries, including the U.S. Though the U.S. was instrumental at the last moment in bringing about agreement at Kyoto, it did not sign the Protocol for many months. The Administration has indicated it has no intention to bring it to the Senate for ratification in the near future, where the prospects for early ratification are dim. As of October, 1998, 57 countries representing in excess of 40% of emissions have signed the Protocol. However, 55 countries representing 55% of emissions of Annex I countries must ratify, not just sign, the Protocol for it to come into force.

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[1] For purposes of this paper, science refers only to the physical sciences and is not intended to include economics or other social sciences.

[2] Eugene B. Skolnikoff, 1990, The Policy Gridlock on Global Warming, *Foreign Policy*, **79**, Summer.

The Protocol specifies a basket of six greenhouse gases[3] targeted for emissions reduction, with allowance to be given for the enhancement of "sinks" for the gases (such as newly planted forests). Reference is made to the possibility of utilizing various means—dubbed "flexibility mechanisms" but now renamed "Kyoto mechanisms"—for reducing the cost of emissions reduction by directing investments to the most cost/effective sites. These include emissions trading, so-called joint implementation, and the creation of a Clean Development Mechanism (CDM). The sinks, the various trading ideas, the CDM, and other unsettled issues (*e.g.*, non-compliance procedures, financial assistance) were discussed at further meetings in Bonn in June, 1998 and at the next Conference of the Parties after Kyoto (COP-4) in November, 1998, in Buenos Aires. No formal agreements were reached on these issues at COP-4; they will require further consideration at several future Conferences.

Primary Factors Affecting the Role of Science

The key factors that affect the role of scientific evidence in any issue are many, but six appear to be of prime importance in the case of climate change: uncertainty of the scientific evidence and forecasts, the structure of government, debatable economic assessments, the international framework, the media, and partisan politics. They are all significant, but the extent of uncertainty of the evidence on this issue permeates and enhances the consequences of all the others.

1. The use of evidence in the face of uncertainty

The issue of climate change relies at its core on scientific evidence and forecasts. There has been no certain demonstration of global warming due to accumulating greenhouse gases in the atmosphere. Rather, the entire subject is on the political agenda because scientists have forecast that there will be warming if gases produced by human activities are allowed to continue to accumulate, as they have been since the beginning of the industrial revolution. A series of hot summers in the 1980s and 1990s appeared to the public to confirm the scientific forecasts, and continuing assessments of the Intergovernmental Panel on Climate Change (IPCC) have strengthened these perceptions. It was the growing concern in the scientific community, and the apparent validation of that concern by the IPCC, that eventually led to the negotiation of the FCCC. The last IPCC assessment in 1995 cited the increase in mean surface temperature and changes in patterns of atmospheric temperature to justify the assertion (in its summary statement) that "the balance of evidence … suggests a discernible human influence on global climate." [4]

But, the evidence is not clear-cut. There are large uncertainties in the interpretation of the evidence, first of all about the basic conclusion of a demonstrable anthropogenic "fingerprint" but, at least as important, about the scale and timing of any warming that might take place. The forecasts

[3] Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.
[4] WMO, UNEP, 1996, *Climate Change 1995: The IPCC Second Assessment Report* (Cambridge University Press).

of scale and timing are crucial to estimation of effects and assessment of costs and benefits, and therefore to the interests that would be affected and to the design of measures to reduce emissions.

Thus, both the evidence of change and the risks involved are characterized by high levels of uncertainty, always a serious (and not unusual) aspect of the formulation of public policy. Uncertainty gives full play to political and economic interests that would be adversely affected by corrective measures to address the risks, since it allows costly measures to be opposed by denigrating the legitimacy of the forecast risks or by arguing the measures are wasteful if the predicted risks cannot be documented. It also leaves the door open for the crafting of alternative scientific analyses, stimulated by those who perceive their interests to be threatened. In effect, those with a political or ideological stake create a constituency for scientists who wish to challenge in either direction the predominant view, in the process exaggerating the apparent uncertainty of the science.

Moreover, uncertainty is not limited to the scientific evidence of warming. The assessment of the likely ecological, physical, and economic consequences of climate change is subject to even greater levels of doubt, and thus of dispute. And the estimated costs of measures to mitigate warming are equally contentious, affected by possible differences in the framework in which those measures would be adopted (*e.g.*, whether emissions trading will be in place or what countries will participate), by assumptions about technological change, and by variations in the temporal sequencing of mitigation policies.

It will be a decade or more before these uncertainties may be substantially reduced. In fact, for quite a while the uncertainties may grow, as evidence accumulates that at times seems to support one view, at times another, as computer simulations allow consideration of a larger number of variables, and as actors in the debates become more articulate in defending their positions.[5]

The result is simply that the level of uncertainty in the evidence, in the assessments, and in the forecasts of costs and damage, will make the task of reaching even temporary closure on policy in the U.S. rife with political controversy. That controversy has already come to the fore, with some major industries taking strong positions against substantial ameliorating policies and against ratification of the Kyoto Protocol, labor unions joining in, and groups of scientists organizing to challenge even the basic scientific argument of the IPCC.[6,7]

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[5] Even if the uncertainties were less pronounced, the issue raises very difficult questions of intra- and inter-generational equity that are highly charged politically and morally, however legitimate.

[6] One typical example is John M. Broder, "Auto Makers See Nothing but Trouble in a Warmer World," *New York Times*, Oct. 16, 1997, p. 19. Some companies, however, are supporting more positive response to Kyoto. "It's Time to Step Up To the Plate on Climate Change," Business Environmental Leadership Council full page ad in *Washington Post National Weekly Edition*, Nov. 9, 1998, p. S6. The Council, with 18 members, includes energy companies such as BP America, chemicals such as DuPont, and aircraft such as Boeing.

[7] A recent example of the challenge to the science involved an astonishing attempt to (mis)use the prestige of science. A former President of the National Academy of Sciences widely distributed a letter enclosing an article, made to appear to be a reprint from the Academy's peer-reviewed journal, debunking the scientific basis of global warming. The article had in fact never been peer-reviewed nor submitted for publication. The organizers were severely criticized by the present President of the Academy.

Another aspect of uncertainty is of central importance on this issue: the potential role that technological change can play in meeting emissions commitments through improvement in efficiency of energy production and use, development of non-carbon energy substitutes, and reduction in the costs of adaptation. The assumptions about technological improvement in these domains are critical to the forecasts of future accumulation of greenhouse gases in the atmosphere and of the costs and scheduling of measures for reducing emissions. Yet, new knowledge cannot be "known" in advance. Moreover, technological change is not independent of policies to induce such change. Hence, public and private sector research and development (R&D) and policies to induce innovation become an important part of the policy mix, though how much technological change will ultimately contribute cannot be determined beforehand. The Administration has emphasized this route as its first response to the Kyoto commitments, and has proposed a 5-year $6.3 billion program of a mix of R&D and incentives for improving efficiency of energy production and use.[8]

2. The structure and politics of government

The structure of the U.S. government makes it harder to reach closure on an issue with such consequential implications and levels of uncertainty than is the case for any other industrial democracy. The government, divided in power between the executive and legislature and based on an adversarial approach to resolving differing policy views, necessarily finds itself in deep conflict on any issue that touches on major interests and ideologies. In addition, almost every agency of the Executive Branch has a legitimate interest in the climate issue; correspondingly, most Congressional committees are or will be involved in the debate, each with turf to defend or expand, and each with a limited vision of the national interest. Moreover, as a result primarily of the fractionated committee structure of the Congress and weak party structure, the legislative process is characterized by easy access to the levers of power for economic, environmental, industrial, ideological or other organized interests.

In this setting, scientific evidence as a dominant basis for policy has a hard row to hoe. Science may be critical to the emergence of an issue on the political agenda, as it is in the case of climate change, or it may serve as the "gatekeeper" influencing how the issue evolves as new knowledge is acquired. But its role in the actual determination of policy at any point in time is typically relegated well behind that of the political, economic and other interests affected. Or, if the level of uncertainty is high enough science is used by all sides in a debate to justify positions reached primarily on other grounds.

The problem is made more difficult by the high visibility of the climate change issue and how much is at stake. Those whose interests will be strongly affected find it more acceptable and more

[8] Council of Economic Advisers, 1998, *The Kyoto Protocol and the President's Policies to Address Climate Change; Administration Economic Analysis*, July, p. 7.

effective to defend their position by arguing about the science rather than their direct interests. Questioning the science is also more productive since most of the public cannot judge the attacks critically and thus can be misled more easily. The result is that the scientific differences are magnified, appearing more uncertain and volatile to the public and to the Congress than would be the case in a less prominent subject or one with fewer consequences.

The role of evidence and analysis is likely to play a larger role in the Executive Branch than the Congress, simply because there is a hierarchical structure (in principle) for reaching and implementing policy, and a process for determining and evaluating the evidence, conducting the analyses, and debating the resultant policy choices. In addition, the White House has an internal structure, including a Presidential Science Adviser, able to lead in the development of the scientific case in the departments and agencies, and present it in the highest policy councils. It would be a mistake, however, to assume that as a result, evidence necessarily plays the dominant role in the determination of an Administration's position. The Administration, too, has many other implications to consider, and many other influences on it, including pressure from industry, concern over the state of the economy and unemployment, likely public reaction to action or inaction, tradeoffs with other policy goals, relations with other nations, and, not least, the ability and willingness to negotiate and sell a policy to the Congress when there are many other issues on the agenda. Finally, there are partisan factors that will affect a party's electoral prospects, and the personal calculations of individuals looking ahead to future elections.

Adding substantially to the difficult politics of the subject is the fact that the benefits of present expenditures will not be realized until far in the future. No politician likes to be faced with that situation, especially if there are significant tradeoffs with other needs on the current agenda (as there always are) and if the need for any action at all can be challenged on the grounds of the case being "not proven." That makes it peculiarly difficult for politicians to take an advocacy position in favor of immediate action, even if they accept the scientific assessments of the IPCC and other evidence pointing in the same direction.[9]

The Congress is in an even more politicized position than the Executive with regard to accepting and acting on the uncertain scientific evidence. Structurally more exposed to stakeholder interests, it will be more embroiled in the volatility of the scientific debate. Moreover, it has no adequate analytical capability of its own dedicated to assessing the validity and implications of evidence.[10] The relevant committees must rely on hearings and staff to acquire and assess the knowledge being produced by the Executive Branch and in the private sector. In that situation, it

[9] This question of balancing future benefits against current costs is a serious problem in the use of cost/benefit analysis on this issue because of the diminishing effect of discounting on benefits that would not be realized until many decades in the future.

[10] The Office of Technological Assessment, a Congressional support agency, was abolished in 1995, and the other Congressional support agencies—the Congressional Research Service, General Accounting Office and the Congressional Budget Office—are not well structured to provide qualified analyses and legislative support on science-intensive issues.

is all too easy for the predilections of individual Congressmen or their staffs—the latter often in powerful positions as a consequence of the organization and constitutional role of the U.S. Congress—to accept or deny the validity of evidence as their politics or ideologies dictate. Considerable uncertainty in the evidence makes it easier for politics to dominate; even a convincing scientific case is often overridden when important interests or influential constituents are adversely affected. The attention to the science in hearings before the Congress and in other forums may give the appearance that the debate is predominantly scientific in nature. But, as noted earlier, affected interests are able to use the inherent scientific uncertainty as an effective way to justify their positions that are in fact determined by other factors.

The progress of the global warming issue through the Congress to date illustrates well the pattern. The threat of higher fossil fuel prices, or regulatory measures that would reduce fuel consumption or force greater efficiency, has led to hearings heavily biased in their selection of witnesses who disavow any scientific basis for concern.[11] In fact, Administration efforts to promote even mild policies that could be justified on grounds independent of the threat of global warming (*e.g.*, R&D to improve efficiency of energy production and use, or experiments with emissions trading) have been attacked by some in the Congress as "end-runs" around the Kyoto Protocol ratification process.

Interests on the other side of the issue, those who would benefit from lower carbon energy sources or higher efficiency, or who favor moderating human impact on the environment on ideological grounds, are of course also able to influence the policy process in both the Executive and the Legislature. For those interests, the scientific evidence, notwithstanding uncertainties, is compelling. At the least, they believe the evidence already in hand argues for following the "precautionary principle"—acting now in case the effects of warming turn out to be real and damaging. For some, especially committed environmentalists, the evidence of climate change is already convincing enough to justify substantial measures today to cut back on greenhouse gas emissions. Several major European nations have, at least rhetorically, taken that position.[12] Vice President Gore was in the latter camp while still a Senator when he published his book, *Earth in the Balance*. He remains the key proponent within the Administration, but the economic and political costs of carrying out his views have prevented the intense advocacy in the White House many had expected.

In the Congress, dominated since 1995 by the Republicans with a strong conservative (even radical) wing, the influence of environmentalists has been muted. The opportunities for

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[11] "The Kyoto Protocol: Is the Clinton-Gore Administration Selling Out Americans?" (Parts I-V), Subcommittee on National Economic Growth, Natural Resources, and Regulatory Affairs, Government Reform and Oversight Committee, U.S. House of Representatives, *press release*, March 2, 1998, "McIntosh to Monitor Clinton Regulatory 'End-Run' on Kyoto."

[12] Eugene B. Skolnikoff, 1997, Same Science, Differing Policies; The Saga of Global Climate Change, MIT Joint Program on the Science and Policy of Global Change, *Report No. 22*, August.

environmentalists to promote the issue through hearings and legislation have been limited and their influence in that body relatively weak. Some industrial companies and organizations have also accepted the evidence as posing a serious risk and have lobbied in favor of policy action to limit emissions.[13] But, their influence, though symbolically important, is so far marginal and will remain so as long as uncertainty remains high.

Further complicating the role of scientific evidence on this—or any—issue are the (sometimes fickle) views of the electorate toward particular classes of policy measures that can serve to limit response options. The attitude to new taxes in the U.S. today is emblematic. Measures to limit or reduce greenhouse gas emissions might well have to include some form of tax to raise the price of fossil fuel. Even if such taxes could be obscured by labeling, or made neutral in their effect by reducing other taxes, they can easily be attacked in a political atmosphere in which any tax "increase" is politically unacceptable. And, since those interests negatively affected are likely to be clearly focused and politically powerful, while the benefits are long-range and dispersed, any such proposal is doubly in danger.

The separation of powers between the Executive and the Legislature, coupled with the shared power in the Congress between Senate and House and the decentralization of authority within both Houses among many committees creates an additional problem. It is that the negotiations among the domestic players and the tradeoffs necessary to reach agreement are likely to be extremely complex on a consequential issue of this kind. Moreover, the tradeoffs in that negotiation may be quite different from those involved in the negotiation at the international level.[14]

Given all this, it may seem surprising that the Administration did agree to a cut of 7% in U.S. emissions below the 1990 level by the 2008-2012 time frame. But, the Administration, and particularly the Vice-President, had made an earlier commitment that could not be disregarded. This was especially so in the context of an international negotiating process that had developed considerable momentum and could not be ignored or deflected without political cost. By the end of the Kyoto negotiations, it seems the Administration must have calculated it would pay a higher political price at home if it scuttled the negotiations (U.S. participation is essential) than it would by acceding to some commitment. In addition, the terms of the Kyoto Protocol provide a variety of possible loopholes (additional greenhouse gases to be considered, credit for sinks) that may allow fulfillment when the time comes. Moreover, neither immediate nor early policy action much before 2008 appears urgent on political grounds, though a delay in implementation will in fact make the Kyoto target almost impossible to meet. A decade may be a very short time in climate change and capital stock turnover, but it is a long time in politics, especially with three Presidential elections intervening.

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[13] "It's Time to Step Up To the Plate on Climate Change," Business Environmental Leadership Council, *op. cit.*

[14] For example, the bargaining at Kyoto was on issues concerned with emissions commitments and flexibility mechanisms; in the U.S. if it ever reaches that point, it will be on the economic implications and calculations of the measures that would be necessary to reduce emissions.

3. Economic costs and impact

The economic implications of the scientific evidence and of policies to mitigate emissions and adapt to warming necessarily play a central role in determining the politics of the issue. There are several related dimensions: the assessment of the costs to the nation and the world if warming turns out to be substantial and occurs at a rate and timing that follow the more draconian scenarios;[15] the estimates of the costs of policies to control or reduce emissions, especially by comparison with the impact costs of warming; the effects on international competitiveness if commitments among nations are uneven, as they will be since major developing countries have no commitments; and the effects on jobs and growth in specific industries or sectors.

All of these costs and effects are more speculative than the underlying science and are less rather than more amenable to convincing analysis. Even that portion of the issue most directly tied to science—what advances can be expected, for example, from R&D on alternative energy technologies—cannot be determined in advance. The canonical figure frequently employed by many economists, 1% per year improvement in productivity (primary energy consumption per unit GDP) as a result of technological change, is not necessarily an appropriate estimate of the future.[16] It, or any reasonable alternative, are exogenous assumptions, adopted for the purpose of constructing a model, rather than derived from evidence. In any case, the increase in productivity due to technological change can be affected in uncertain ways depending on the extent of commitment of resources to R&D.

There is considerable analysis attempting to understand what the economic costs of impact, mitigation and adaptation may be and how to design policies to minimize them.[17] These analyses are necessarily based on a variety of assumptions and estimates that by their nature cannot be certain. They also have the characteristic of suggesting policies that may be analytically desirable, but politically questionable. For example, most economists would agree that an efficient emissions trading system would serve to minimize the costs of reducing emissions over the next century. But, the likelihood of being able to put in place even a marginally satisfactory trading system, let alone an optimally efficient one prior to 2008, is slim indeed. The conditions that would have to be met (*e.g.*, agreed national caps on emissions, an effective emissions monitoring capability, initial allocation of permits that would appear to reward existing patterns of consumption, and others) are not only onerous to negotiate, but in many cases would be politically inflammatory.

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[15] Henry D. Jacoby, Ronald G. Prinn and Richard Schmalensee, 1998, The Road From Kyoto, MIT Joint Program on the Science and Policy of Climate Change, *Report No. 32*†, March, p. 3; †*version 1*, superceeded (citation *20*).

[16] The IPCC used the same 1% increase per year assumption in their "business as usual" forecast.

[17] There is a large and growing literature on the economics of climate change. Some of the most substantial and continuing work has been done by Alan Manne and Richard Richels. See for example, Alan S. Manne and Richard G. Richels, 1992, *Buying Greenhouse Insurance: The Economic Costs of CO_2 Emissions Limits* (MIT Press), and subsequent work. See also, William D. Nordhaus, 1994, *Managing the Global Commons: The Economics of Climate Change* (MIT Press), and Henry D. Jacoby *et al.*, 1997, CO_2 Emissions Limits: Economic Adjustments and the Distribution of Burdens, *The Energy Journal*, Vol. **18**, No. 3.

Thus, the crucial question of the economic costs—crucial because they loom large in the political process in the absence of definitive evidence of ecological danger—is even more uncertain than the scientific evidence itself. That economic uncertainty gives free rein to those interests who believe they will be affected, whether positively or negatively, to attempt to influence policy in ways they will find beneficial. The scientific, or even analytical economic underpinning, of their positions becomes rather irrelevant, since the base is unclear and the analysis built upon it can easily be "adjusted" to support whatever position is desired.

Even in the present economic "climate," with the U.S. economy continuing strong, neither the Administration nor the Congress (nor the public for that matter) is inclined to support policies that might dampen the economy. At least that is so in the absence of definitive evidence of looming ecological crisis. It is irrelevant to the politics of the issue whether or not mitigation measures in the long run would have only minor integrated economic costs or in fact could benefit some sectors, or whether policies could be designed that would apportion the burden equitably, or whether enhanced tax revenues could be used to offset other tax burdens. Policies to limit emissions appear to endanger the present economic prosperity, or can easily be made to appear to do so. This is not a proposition any politician is willing to support in the absence of a convincing assertion of serious danger, even though the present confluence of a strong economy and low fuel prices would seem to be the most favorable time for action.

Further bedeviling the issue is the existence of economic developments that have other causes, but that make this issue more difficult to deal with. For example, higher prices of fossil fuels—the consumption of which is the major source of anthropogenically-produced CO_2—would not only serve to reduce the amount consumed, but would also create an incentive for development of more efficient energy generation technologies. But, the price of oil has fallen steadily in recent years, due to oversupply in relation to demand, to a level approximating the inflation-adjusted price at the time of the 1970s oil shocks. Global warming concerns had nothing to do with this. But, the fact of the oil glut and the concomitant lower prices encourage the use of fossil fuels. It makes the overall task of reducing CO_2 emissions more costly and politically problematic, whatever the scientific evidence.

4. International structure and U.S. response

Global warming is quintessentially a global problem. No nation can solve it on its own, and all will be affected if and as it occurs. An international process growing out of the concerns of scientists has coalesced in a remarkably short time. A secretariat has been established in Bonn to serve the FCCC, an international scientific assessment process (IPCC) involving thousands of scientists around the globe is actively at work, the Kyoto Protocol that sets specific targets and timetables was negotiated, and a plethora of international meetings, travel and negotiations is underway. A process with significant momentum has begun; nations have to debate internally what

their positions and policies should be. And now, after Kyoto, the industrial nations have to decide whether to accept formally the first internationally mandated obligations.

The unfolding of this international process is in many ways astonishing; it is perhaps the fastest moving international mobilization on an environmental issue that the world has ever seen, with the possible exception of the Montreal Protocol that dealt with an important issue—damage to the Earth's ozone layer—but an issue that has considerably smaller economic consequence. The scientific evidence as presented by the IPCC, especially the assertion that an anthropogenic fingerprint can be discerned, is without question the core base on which these developments have thrived. Yet, at the same time, a variety of international issues add to the domestic debate that clouds the subject in the U.S.

The most relevant is the eventual role of developing countries (LDCs). It is rightly recognized that some of the larger developing countries, especially China, Brazil, India and Indonesia, will become major emitters of greenhouse gases as their economies grow. Yet, they and all LDCs have been specifically excluded from any binding commitments for emissions reduction under the Kyoto Protocol.[18] That exclusion was agreed to at the time the Berlin Mandate (the negotiating process that then led to Kyoto) was adopted in 1995, largely as a way of focusing initial obligations on the richer and larger emitters, the countries that through their emissions created the current situation. However, without explicit recognition of eventual commitment on the part of all major emitters the way is open for treaty opponents to argue that any agreement means little without the LDCs and would unfairly penalize American companies and American workers. The Senate, which will have to ratify the Protocol, passed by 95-0 a resolution that the President should not submit the Kyoto Protocol for ratification unless it "also mandates new specific scheduled commitments to limit or reduce greenhouse gas emissions for Developing Country Parties within the same compliance period."[19]

Perhaps most important of the international aspects is the response in the U.S., especially in the Congress, to any issue in which the UN and the international community must play a central role. There is a climate of xenophobia in the Congress, reflected to some degree in the electorate, that is challenging the role of the nation in world affairs and particularly in the work of the UN and its associated bodies such as the World Bank and the IMF. The mindless fears of UN "black helicopters" are certainly an extreme, but the current mood, often reflected in Congressional statements and votes, sees a vocal portion of the public turning away from foreign involvements, questioning immigration, and rejecting policies that are perceived as in any way infringing American sovereignty. In that context, an agreement negotiated under the auspices of the UN that if carried out would certainly have an impact on the American economy is immediately suspect.

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[18] There is one implied reference (not a commitment) to the LDCs in the article dealing with a "Clean Development Mechanism."

[19] Senate Resolution 98, 105th Congress (the Byrd-Hagel Resolution).

The scientific evidence is of little moment in that situation, especially since it cannot be claimed that in the absence of an agreement ecological disaster is certain.

These international issues that overshadow the science carry more weight because the Kyoto Protocol may well be a flawed approach to dealing with the threat of global warming. The Kyoto agreement on specific emission reduction targets to be achieved by 2008–2012 has established a target the U.S. almost certainly will be unable to meet, especially given the increased emissions as a result of robust economic growth since 1990. In fact, by focusing attention on near-term targets, the Protocol detracts from the essential long-term goal of creating the architecture and policies that will be necessary to meet the centuries-long needs of the issue, including determining an acceptable ultimate concentration of CO_2 in the atmosphere, establishing a trading system that can minimize costs, mounting a sensible R&D program, and finding ways to enlist developing countries.[20] These and other needs take time and experiment to bring to fruition and to reach agreement; failure to meet a rather arbitrary and costly short-term goal (an emissions reduction target in ten years) can undermine rather than support these much more important long-term needs.

The Administration agreed to the Berlin Mandate process,[21] even though clearly flawed; Kyoto was the result. Now, there is the danger that the whole process will be tainted by the unrealistic actions of its supporters no less than by its opponents. If the U.S. refuses to ratify Kyoto, or cannot fulfill the commitment made in it, the resulting disillusionment with the issue could be a severe impediment to the development of an international structure that might prove to be essential in the next century.

5. The media and the public

At least as important to public perceptions as the actual scientific evidence and the economic analyses building on it, is the way the media plays the issue. The media prefers issues that are either controversial or apocalyptic, with high news value as a result. Global warming can fit both criteria.

Hence, the largely empty debate between the small band of climate "skeptics," who are certain that climate change is not a threat, and most of the scientific community, receives a substantial press. The implication is there is something of a standoff between the two, a considerable misreading of the actual situation. Or, evidence of ecological change and unusual weather events tends to receive much press attention implying (or claiming) that the evidence indicates the onset of global warming or, at times when the events reflect more cold than heat, that they invalidate the

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[20] Henry D. Jacoby, Ronald G. Prinn and Richard Schmalensee, 1998, Kyoto's Unfinished Business, *Foreign Affairs*, July/August, pp. 54-66, presents a balanced view of the overall issue and the problems that may result from the Kyoto approach.

[21] European countries in the EU pushed hard to set up the Berlin Mandate process, taking positions heavily determined by internal politics and economics more than by realistic ecological concern. A considerable amount of posturing was involved, knowing that the U.S. would almost certainly save them from the substantial emissions reductions they first proposed at Kyoto. This may well in the long run set back rather than advance their avowed goals. For a discussion of the European positions, see citation *12*.

theory. In both cases, the conclusions are an artifact of the way the press handles the issue rather than a true reflection of the scientific evidence and the nature of the scientific debate. This is not surprising nor unusual, especially when the evidence is fuzzy and most reporters are not able to judge the subject critically.

The public in this situation cannot help but be confused, especially when the information presented in the media is used by proponents to support whatever their position may be. In the absence of clear and much more certain science, this pattern is unavoidable. And, it appears clear, the science will not be sufficiently certain to short-circuit these divisions for many years into the future.

The other side of that coin, however, is that ecological events of sufficient severity and multiplicity may be enough to trigger public acceptance of the validity of the global warming forecast, whether or not they can be responsibly (*i.e*. scientifically) tied to the theory. The El Niño events of 1997/8, with major repercussions on many continents were such an example, even though it was a known phenomenon long before global warming appeared on the scene. The succession of 100˚ days in Texas in the summer of 1998 may prove to be another indicator the public accepts as evidence of global warming. In any case, it will most likely take the occurrence of a major ecosystem event that can believably be tied to global warming to transform the debate in the public's mind and to lead to public support of measures to respond. Absent such an event, the debate in the U.S. is likely to turn not on the science, but on the myriad of other issues raised by the subject.

6. Partisan politics

Finally, the role of partisan politics on this issue is of central importance. The Republican party, especially its majority in both Houses of the Congress, sees this issue as one that has been adopted and pursued by a Democratic Administration, even though it was first placed prominently on the agenda by the previous Republican Administration. In particular, it is an issue long espoused by the Vice President who is, not irrelevantly, likely to be the Democratic candidate for President in 2000. This situation is ready-made for a partisan approach in which the Republicans emphasize possible high social costs of adherence to Kyoto, while the Democrats play down the costs of adherence. The uncertainty of the scientific evidence and forecasts makes it easy to take this tack, in fact tending to force exaggerated claims of impending danger on the part of the Administration in order to attempt to make its case.[22]

Though much of the debate appears to turn on the scientific evidence, that is largely a convenient cover for the other political issues at stake. In fact, it is an issue likely to be pursued

[22] As one Congressional staffer noted: "The reality is that anything with Gore's name on it is dead on arrival up here." *Nature*, 23 July, 1998, p. 305. In the same piece, Vice President Gore was quoted as saying (in reference to the Texas heatwave and the forest fires in Florida) "The evidence of global warming keeps piling up."

by the more conservative elements of the Republican Party, some with vocal nationalist and xenophobic views since it offers many opportunities to play to related preferences of the American public: against new taxes, no export of jobs, reduced role of government, and anti-UN sentiment.

The Administration has a difficult case to make to have the Kyoto Protocol ratified by the Senate. It is a job not made easier by the disproportionate voting power of Senators from natural resource-rich states. In fact, the Administration is unlikely to even try to do so until after the Presidential election of 2000, though the 1998 mid-term election may have improved the prospects for the treaty. Even though the party lineup in the Senate remained unchanged, two prominent opponents (Faircloth and D'Amato) were defeated. Thus, it will remain prominently on the agenda well into the future, masquerading as a scientific issue, though in fact much more closely resembling traditional political controversies.

Conclusions

Global warming is an issue of potentially enormous environmental, political and economic consequences that was introduced to the national and international agenda by science and scientists. It has moved rapidly to the development of an international process that has engaged nations, publics and the UN in substantial institution building, interaction and negotiation. Yet, today it has become entwined in the U.S. in internal political and economic debates that are not independent of the science, but are made possible by the level of uncertainty of the science. As long as that uncertainty persists, these other factors will flourish and bedevil the ability to determine a consistent agreed policy direction.

The level of uncertainty does not have to be removed entirely to move to a new level of political consensus. Continuing research to understand the forces at work and to identify indicators and options are essential, and will gradually lead to a greater level of knowledge about the issue and to elaboration of real policy choices. The scientific and engineering communities (including social scientists and especially economists) have a major responsibility to maintain their professional values and objectivity in this situation so dominated at the moment by other pressures.

Maintaining objectivity, and the perception of objectivity, is often not as easy as it sounds. Personal views about the threat inherent in climate change, or on the other side concern over unjustified and costly policies, lead many scientists to wish to intervene in the policy arena. That may be justified and appropriate on an individual basis for some, but the importance of maintaining a credible scientific base for the formulation of policy measures and for public acceptance of those policies cannot be overstated. At a time when many argue for a greater political role for the scientific community in this and other policy matters, it is critical that the public at large and those responsible for policy retain an essential trust that the scientific community remains objective and is not slanting its results according to preconceived prejudices. That speaks not only to individuals, but also to the conduct of the leading scientific assessments, especially those carried out by the

IPCC. The somewhat sloppy procedure for assembling the "Summary for Policymakers" of the Second IPCC Assessment, which allowed accusations of bias in that process, must not be allowed to recur.[23] The stakes involved in ensuring that the scientific forecasts are of high quality and disinterested are too large.

Growing scientific consensus is only one way that the science will move the issue forward and lead to greater political consensus. At least as likely is the emergence of an ecological crisis that can plausibly be linked to global warming, whether the link is proven or not. The El Niño events of 1998, the damaging hurricanes of the 1998 season, and the floods in Texas, all contribute to that sense of climate change. Taken individually, none of these are of sufficient drama or have a convincing tie to global warming to lead to a political shift in the U.S. But, more dramatic events could do so, especially if the media asserts a presumed cause and effect relationship. A major shift in the climate of northern Europe, which could be highly sensitive to the rate of climate change, would undoubtedly change public attitudes. Less spectacular events, such as continuing hot summers accompanied by more numerous and intense storms, could also gradually convince the body politic that the issue cannot be ignored and must be dealt with, even if costly.

Whether the body politic comes to understand the issue through the gradual development of scientific consensus, or through the mechanism of an ecological crisis, it is essential that the underlying research continue to advance and to be adequately communicated to the public and to policy-makers; the basis for designing and implementing the policy measures that may be necessary depends on it. And, obviously, this implies not only continuing attention to the fundamental phenomenon of climate change, but to the even less certain questions of effects of change, of the means to bring about emissions reductions at minimum cost and, since substantial accumulation of greenhouse gases in the next century is assured whatever actions are undertaken, of the options available to adapt to climate change if necessary. It will be essential, and will greatly ease the political difficulty of taking action, if there are options for policy that reduce the costs of action and of the costs to the major stakeholders.

The menu of the scientific and technological communities is large, even if at present political factors dominate the analyses. Eventually, the work of these communities will be the necessary underpinnings of agreed policy decisions. But, it is important not to assume that the outputs of current research and analysis will automatically determine policy. Those outputs will enrich the debate, but the debate for some time will turn on a different calculus. Disillusionment is not useful; realistic assessment of the role of knowledge is.

[23] Ehsan Masood and Ayala Ochert, UN climate change report turns up the heat, *Nature*, Nov. 9, 1995, p. 119.